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RADIO CORPORATION OF AMERICA

DEFENSE ELECTRONIC PRODUCTS

AEROSPACE COMMUNICATIONS AND CONTROLS DIVISION

CAMDEN 2, N.J., BURLINGTON, MASS.

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28 March 1963

ADDENDUM To

Study Report for the Integration of

DIGITAL DATA COMMUNICATIONS SET

AN/ASW-21

Into the F8U-2N/2NE, A3D-2/2P/2Q, A4D-2/2N/5,

A3J-1, and A2F-1 AIRCRAFT

Contract Modification No.

C/N 5307-63

Contract No.

NOw-61-0918-c

Prepared for: Bureau of Naval Weapons
Department of the Navy
Washington 25, D. C.

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I. Introduction

When the Study Report for the Integration of the Digital Data Communications Set AN/ASW-21 into the F8U-2N/2NE, A3D-2/2P/2Q, A4D-2/2N/5, A3J-1 and A2F-1 Aircraft was released in March of 1962 the AN/ASW-21 was still in the development stage and as a result some of the detailed specifications listed for this equipment, and the Data Link Flight Line Test Set AN/ASM-98A were not completely accurate as stated. In addition, the AN/ASW-21 Mounting Bases, MT-2866, MT-2867 and the Bench Test Harness, Digital Data, AN/ASM-128 were not included in the original Navy Contract N0W-61-0918c and were not described in any great detail in the Study Report.

This addendum is intended to provide corrections to the report where required and a more specific description of the AN/ASW-21 Mounting Bases and the Data Link Bench Test Harness. No attempt has been made to provide a complete detailed performance specifications for these equipments, because these specifications are available at the Bureau of Naval Weapons.

II. Digital Data Communications Set, AN/ASW-21

The AN/ASW-21 is a universal Data Link equipment which is designed for use with a wide variety of Navy aircraft. Its standardized design reduces logistics problems and avoids a large inventory of electronic spare parts. In addition, this universal design permits future expansion with redesign, thereby avoiding the high cost of obsolescence. The AN/ASW-21 can be integrated into each aircraft with special mating equipments in the form of data processing, display, and autopilot coupling units, which will be provided by the aircraft manufacturers.

I. Introduction

When the Study Report for the Integration of the Digital Data Communications Set AN/ASW-21 into the F8U-2N/2NE, A3D-2/2P/2Q, A4D-2/2N/5, A3J-1 and A2F-1 Aircraft was released in March of 1962 the AN/ASW-21 was still in the development stage and as a result some of the detailed specifications listed for this equipment, and the Data Link Flight Line Test Set AN/ASM-98A were not completely accurate as stated. In addition, the AN/ASW-21 Mounting Bases, MT-2866, MT-2867 and the Bench Test Harness, Digital Data, AN/ASM-128 were not included in the original Navy Contract N0w-61-0918c and were not described in any great detail in the Study Report.

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The Digital Data Communications Set, AN/ASW-21, consists of a Converter, Digital-to-Digital/Analog, CV-1292/ASW-21, a Computer, Aircraft Control, CP-671/ASW-21, and a Control, Data Communications Set, C-4085/ASW-21.

The electrical and mechanical characteristics of the equipments are listed in Table I and shown in Figures II through VIII. The AN/ASW-21 receives and processes the information transmitted to the aircraft from the control center for display or autopilot use. In addition, it processes and transmits to the control center information on aircraft position, altitude, and airspeed and the status of the aircraft subsystems. The Digital Data Communications Set, AN/ASW-21 operates with an associated Receiver-Transmitter, AN/ARC-88 or AN/ARC-75. This receiver transmitter operates in the 225-mc to 399.9-mc band in 0.1-mc carrier frequency increments, thereby providing 1750 possible radio channels. Frequency-shift keying is employed in which a binary ONE is presented by a signal of 20 kc above, and a binary ZERO by a signal of 20 kc below the carrier frequency. The equipment is capable of receiving and transmitting 5,000 bits per second. The time-division technique permits reply and control messages to be accommodated on the same UHF channel.

TABLE I. AN/ASW-21 ELECTRICAL AND MECHANICAL
CHARACTERISTICS

<u>Item</u>	<u>Characteristics</u>
Aircraft Power:	
AC	Three phase, 4-wire, 380 to 420 cps; Voltage limit, 108 to 121 volts rms; power required, 255 volt amperes.
DC	27.5 volts dc; limits, 25 to 29 volts dc; power required, 30 watts.
Environmental:	Altitude: 70,000 feet. Temperature: -55°C to +55°C (Continuous), -55°C to +71°C (30 minutes). Humidity: up to 100 percent. Shock: 15 g's with duration of 11 ± 1 millisecond. Vibration: MIL-T-5422 curves II and IV.
Heat Dissipation:	Approximately 268 watts.
Size and Weight:	Converter, Digital-to-Digital/Analog, CV-1292/ASW-21 19" L x 5.25" W x 7" H 34 lbs.
	Computer, Aircraft Control, CP-671/ASW-21 19" L x 7.5" W x 7" H 48 lbs.
	Control, Digital Data Communications Set, C-4085/ASW-21 2"D x 5.75" W x 2.625" H 1.5 lbs.



CONVERTER CT-1292/ASW-21
AIRFLOW vs. INLET AIR TEMP.

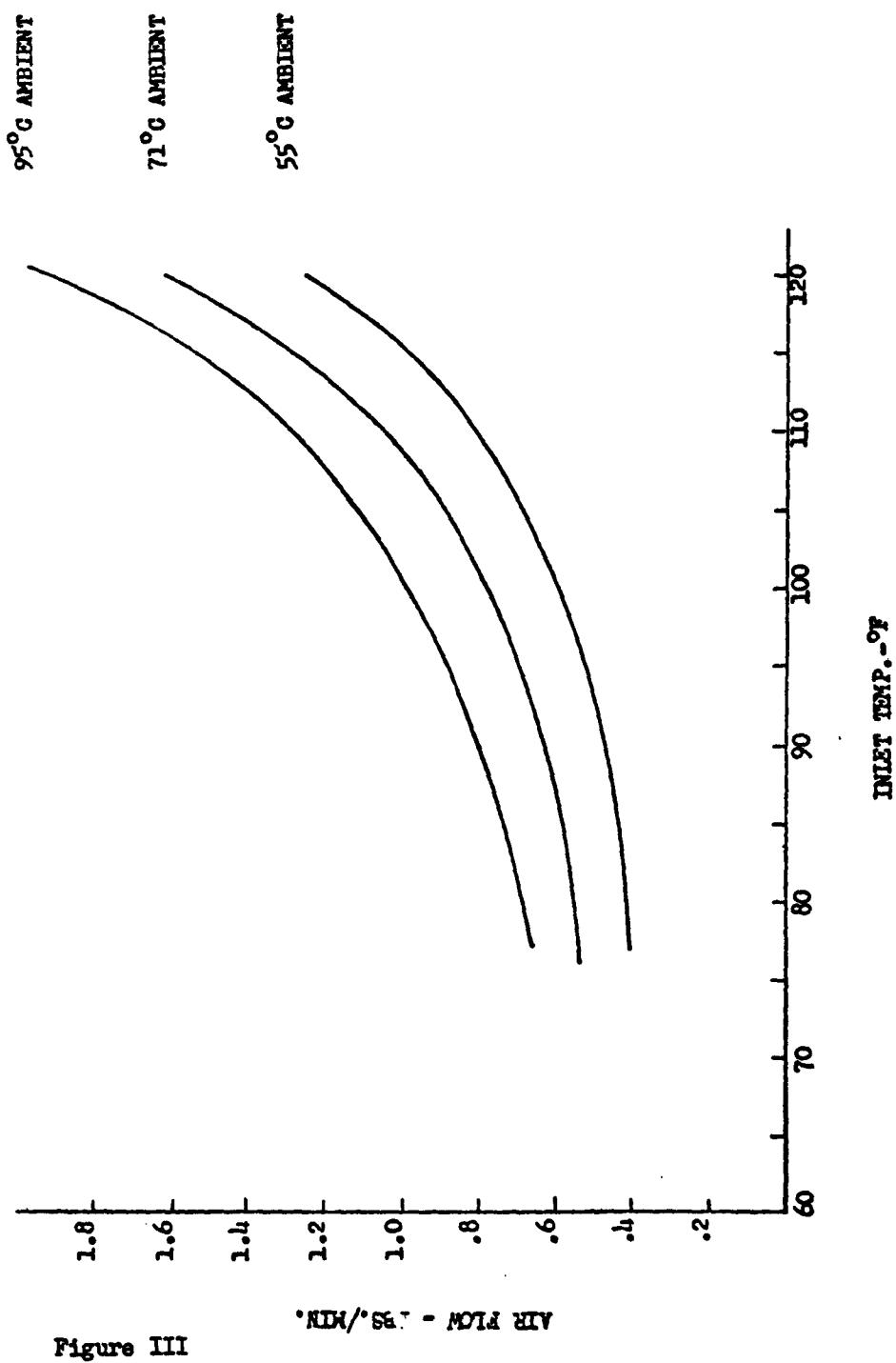
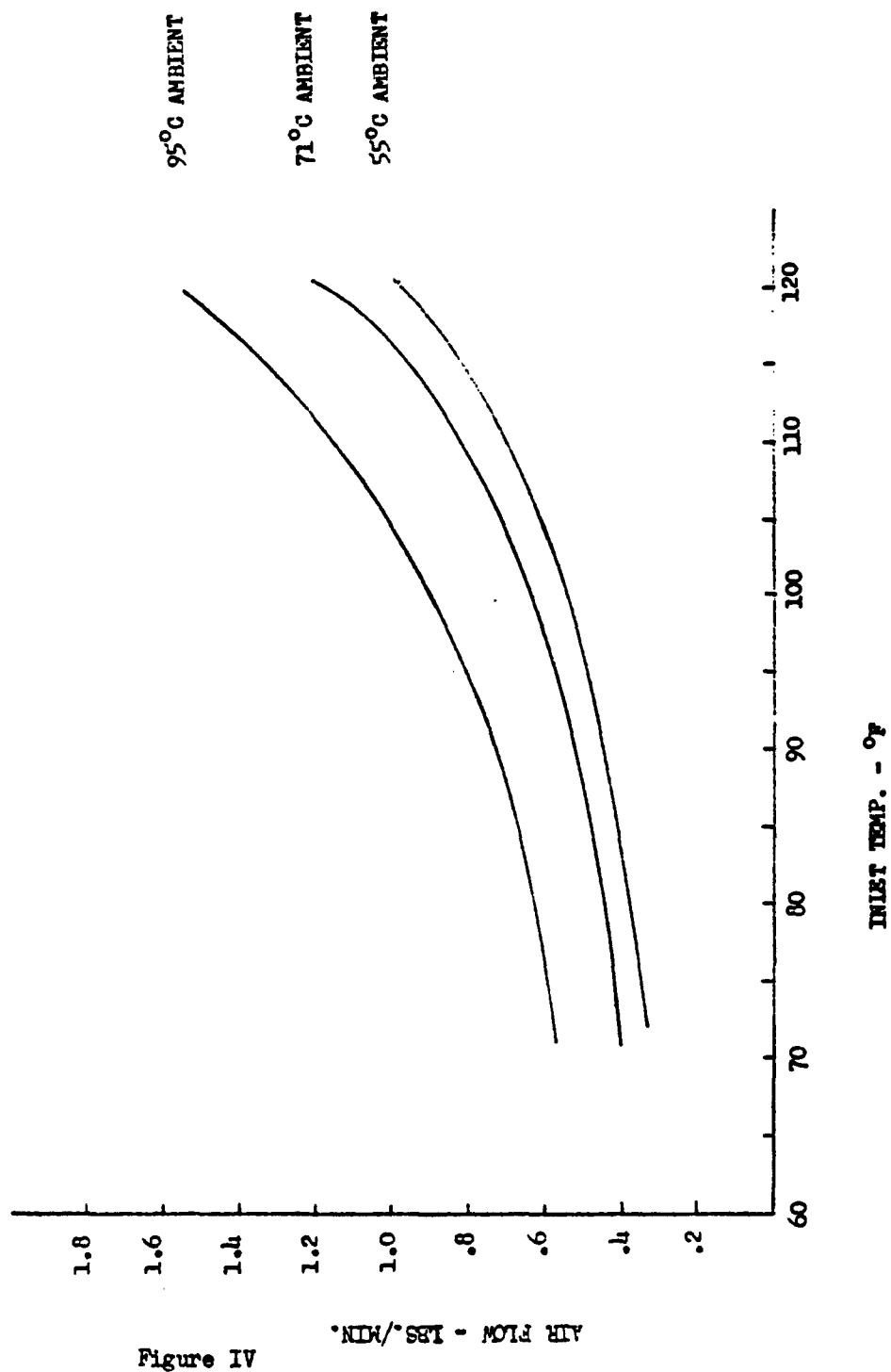


Figure III

COMPUTER GP-671/ASM-21
AIRFLOW vs. INLET AIR TEMP.



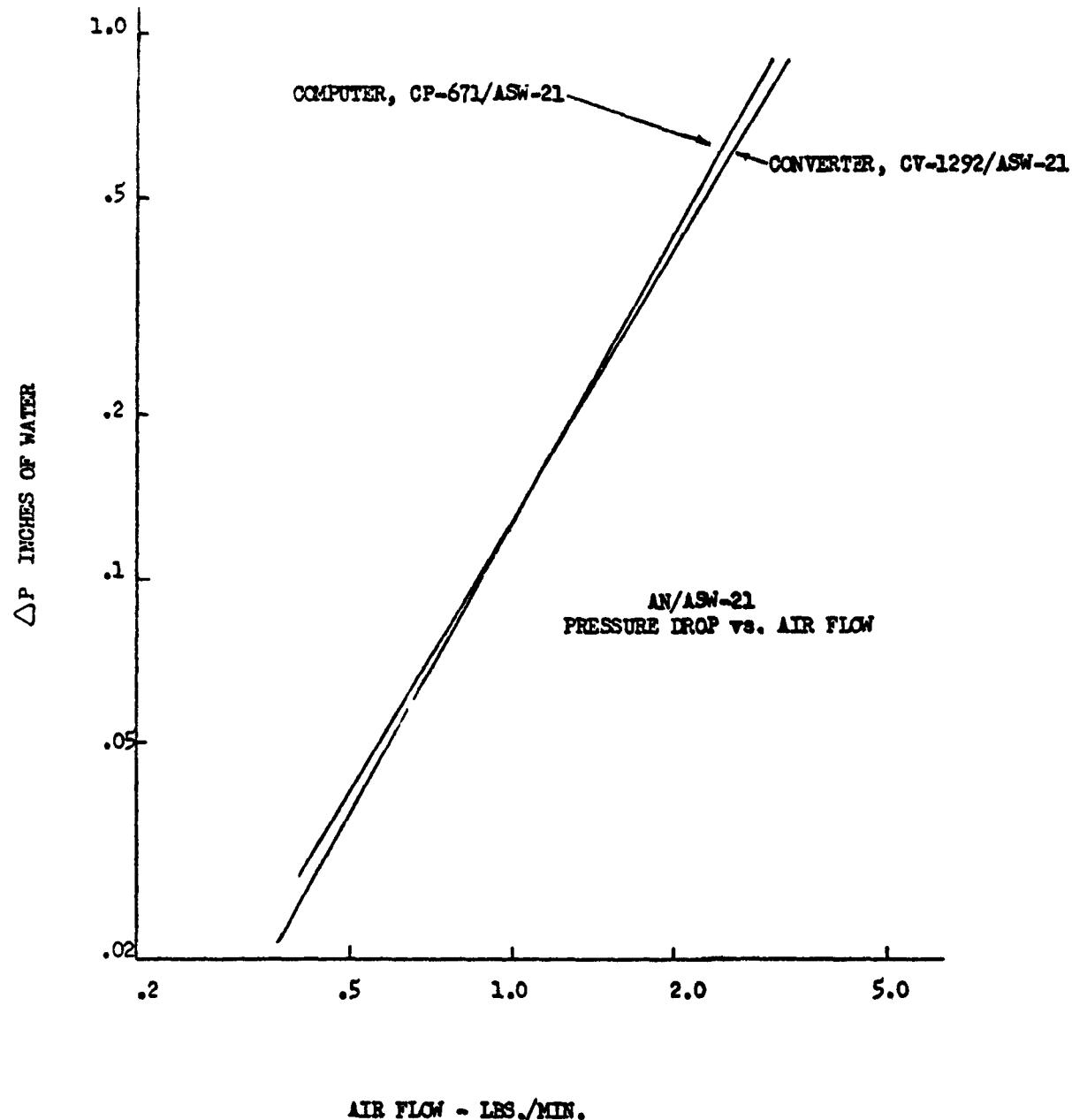
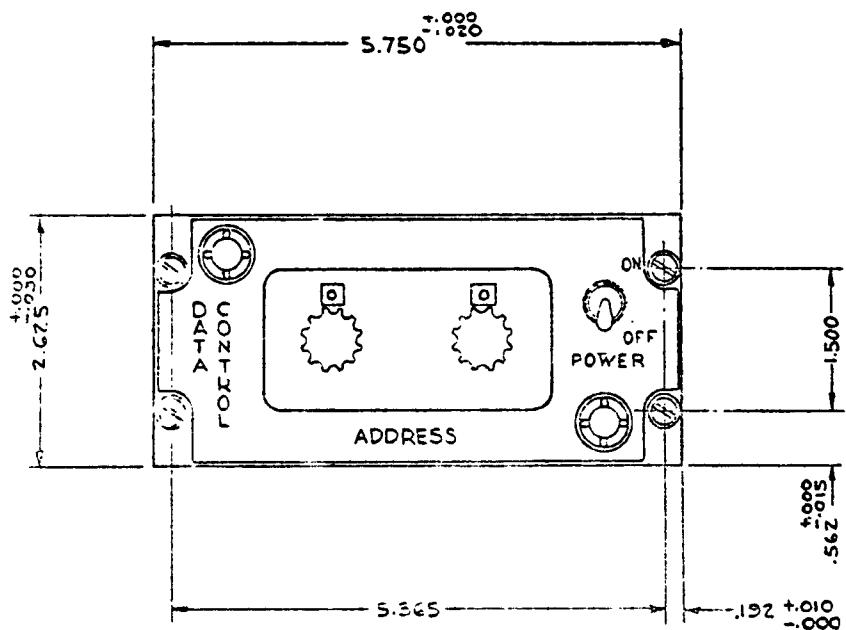
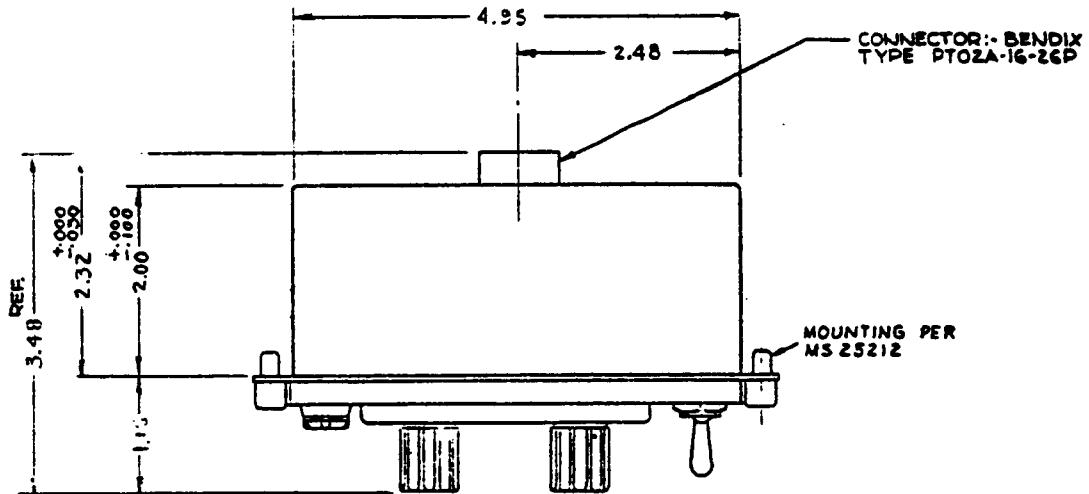
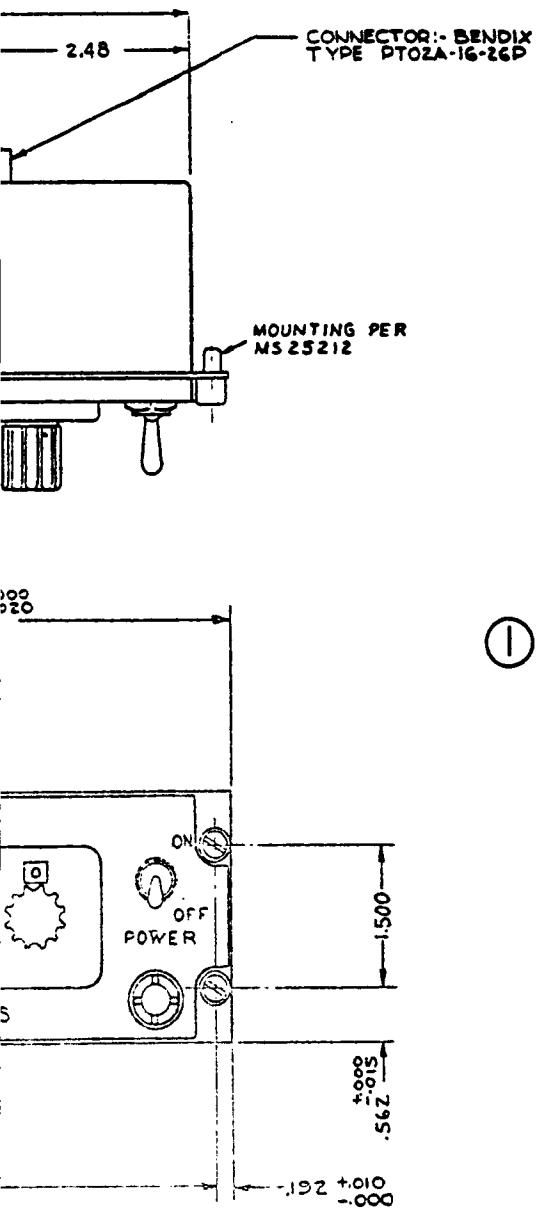


Figure V



NOTES

1. EST. WEIGHT 2 POUNDS
2. HEAT DISSIPATION - NEGLIGIBLE



(1)

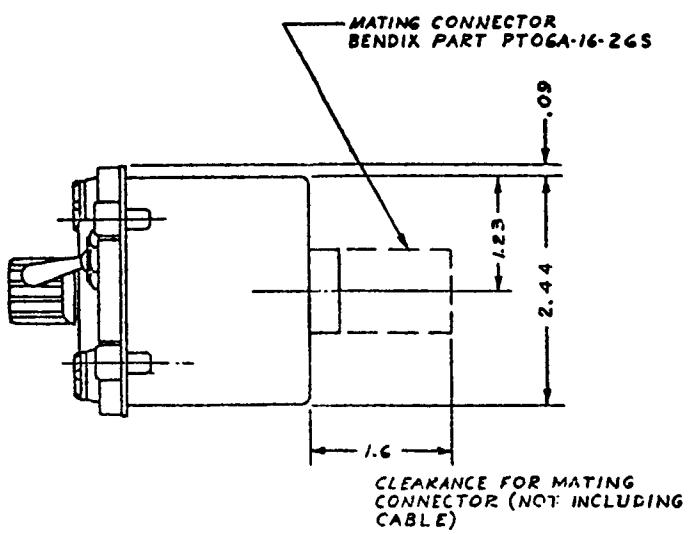
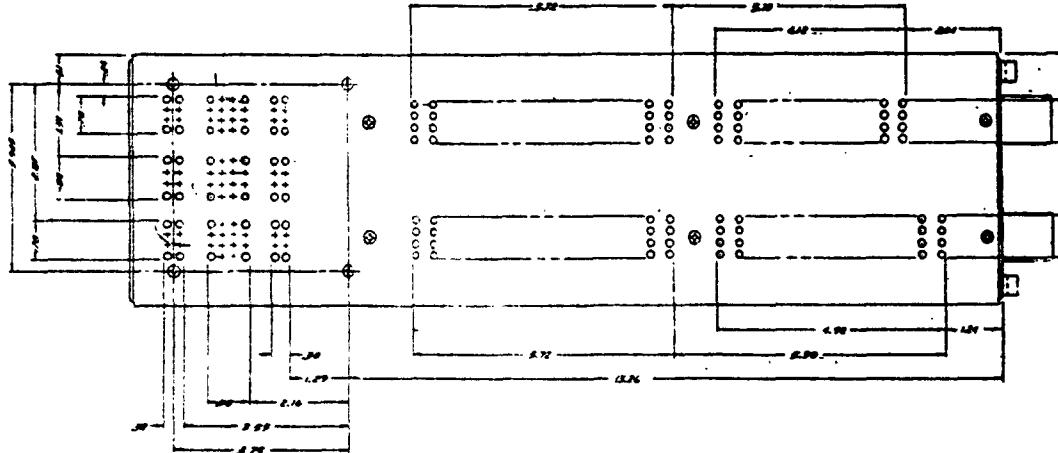
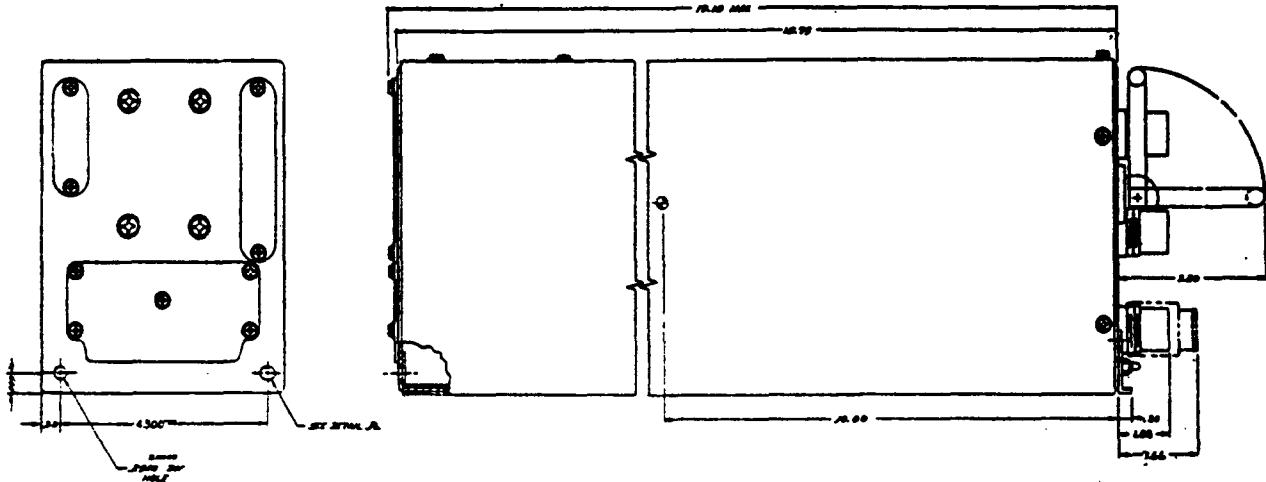
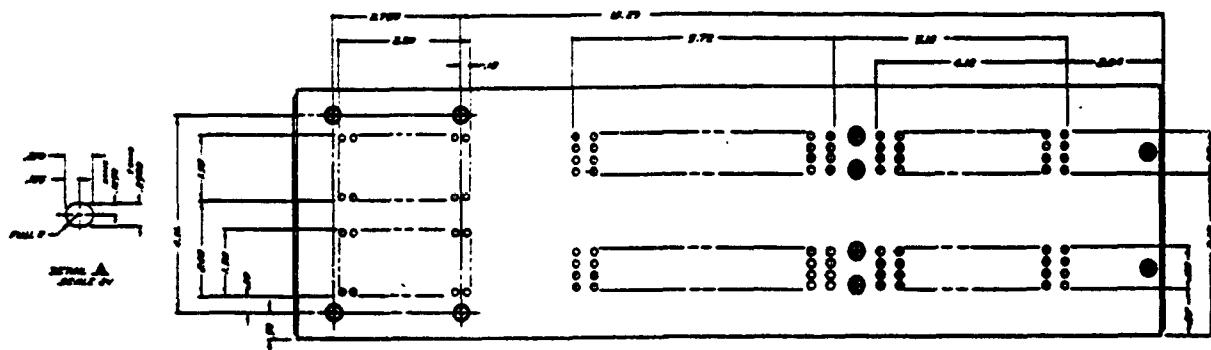
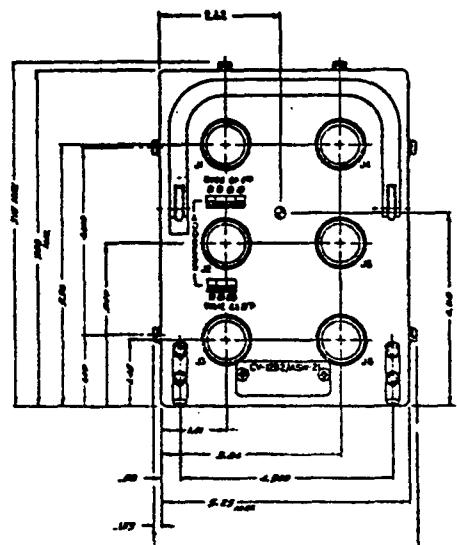
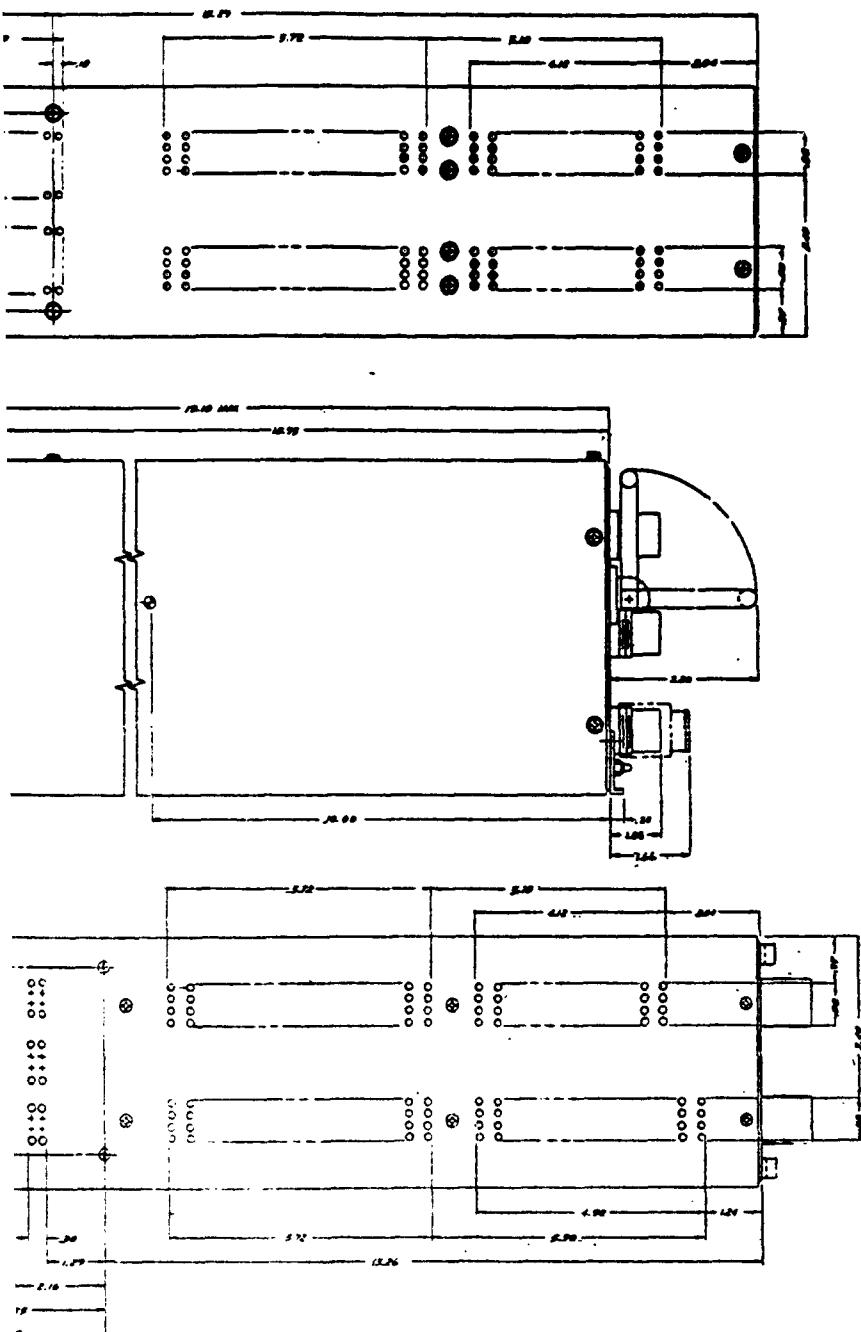


Figure VI
Outline and Mounting Char-
acteristics for C-4085/ASW-
21 Control Box



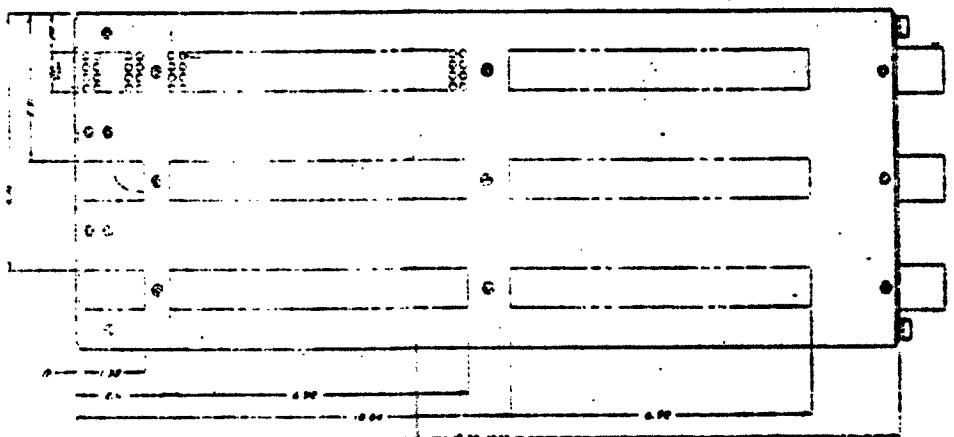
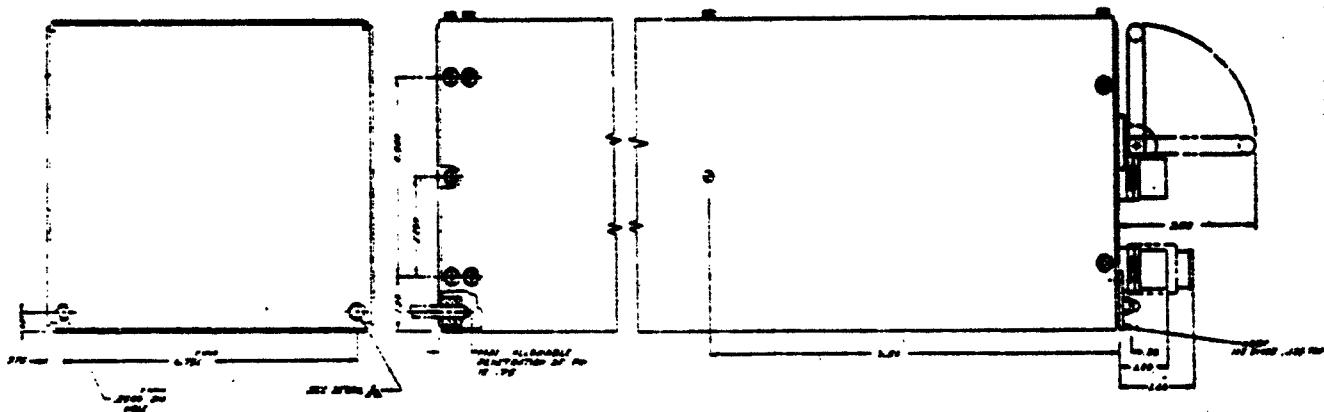
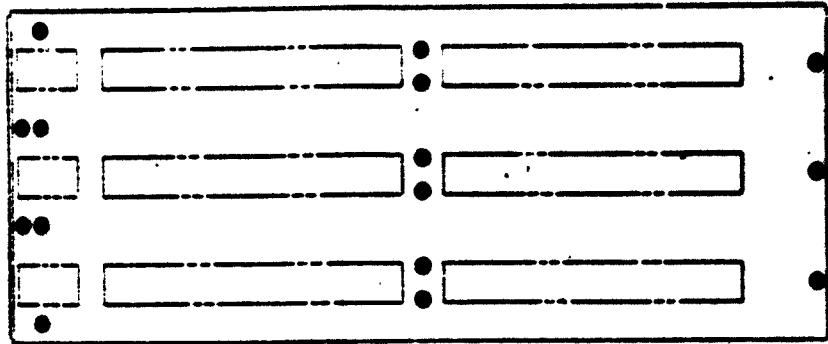
NOTE
1 HEAT DISSIPATION IS 105 WATTS
2 WEIGHT OF UNIT IS 34 LBS





COMP	MICRODOT CAT. NO.	COMP	MICRODOT CAT. NO.
PLATE		PLATE	
P1	C-632P7-43-1 (0010)	J1	C-632P7-43-2 (0010)
P2	C-632P7-43-3 (0010)	J2	C-632P7-43-3 (0010)
P3	C-632P7-43-4 (0010)	J3	C-632P7-43-4 (0010)
P4	C-632P7-43-5 (0010)	J4	C-632P7-43-5 (0010)
P5	C-632P7-43-6 (0010)	J5	C-632P7-43-6 (0010)
P6	C-632P7-43-7 (0010)	J6	C-632P7-43-7 (0010)

Figure VII
Outline and Mounting
Characteristics of CV-
1292/ASW-21



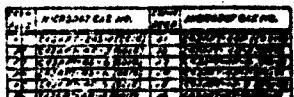
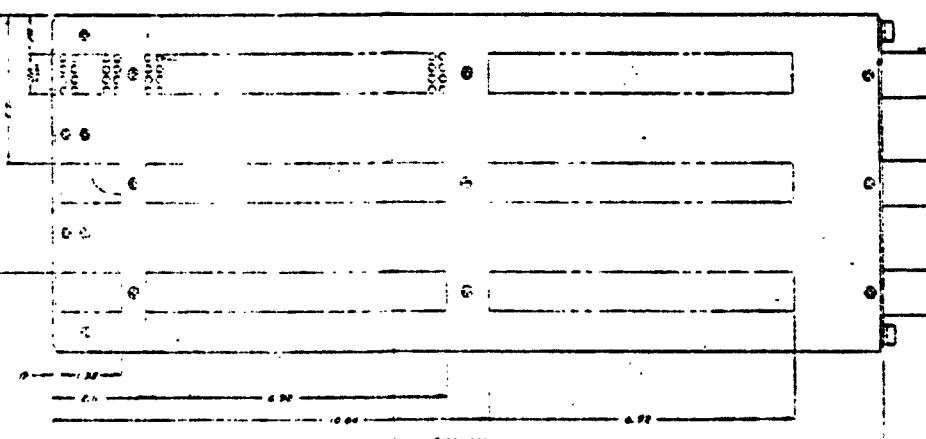
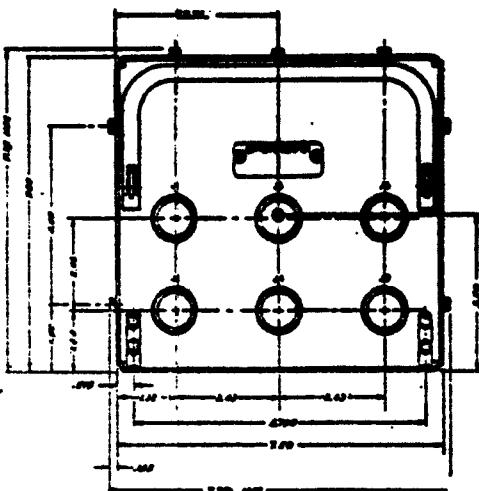
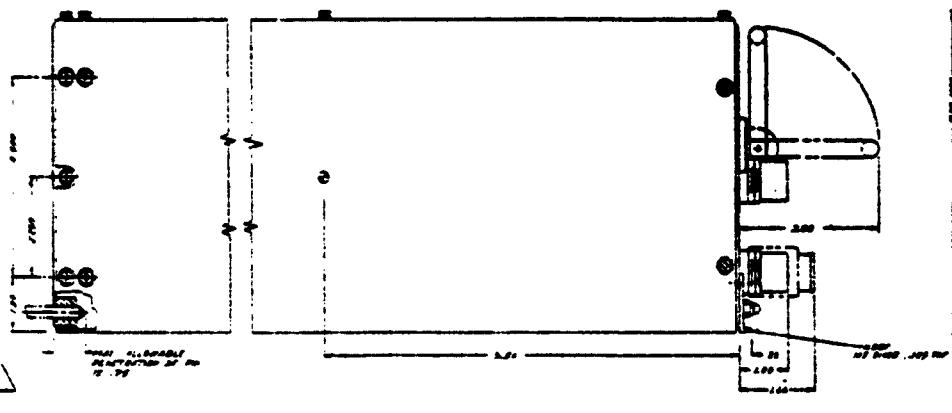
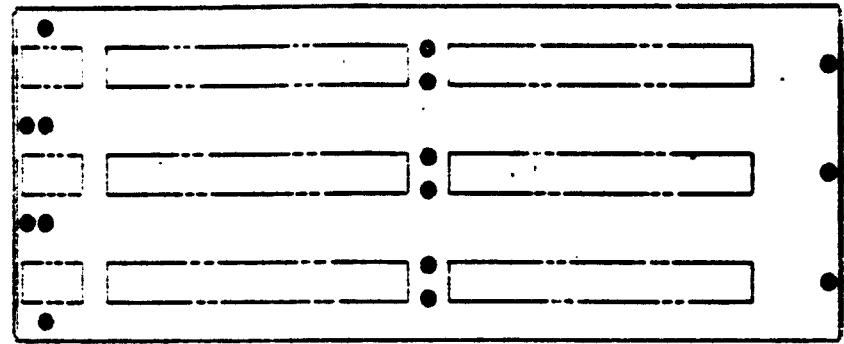


Figure VIII
Outline and Mounting Char-
acteristics of CP-671/ABW-
31 Computer

III. Mounting Bases, MT-2866/ASW-21 and MT-2867/ASW-21

The mounting bases are custom designed and tested to attenuate the transmission of vibration and shock disturbances from the aircraft to the AN/ASW-21 equipment. The bases are configured to isolate and support the Converter, CV-1292/ASW-21 and the Computer, CP-671/ASW-21 individually to achieve the greatest flexibility for installation.

Complete physical support for the AN/ASW-21 units is provided by the mounting bases, shown in Figure I, IX and X. The units are secured to the bases by a bayonet pin and socket arrangement at the rear and by knurled retaining clamps at the front.

In addition to providing the required isolation from shock and vibration, the mounting bases incorporate an air plenum in the available space between the isolators under the mounting surface. The function of the plenum is to provide a static reservoir for the cooling air required by the units. Air is brought into the plenum from the aircraft cooling supply through either the front or rear inlets provided on the bases. Mounting dimensions for the input duct connectors are shown in Figure XI.

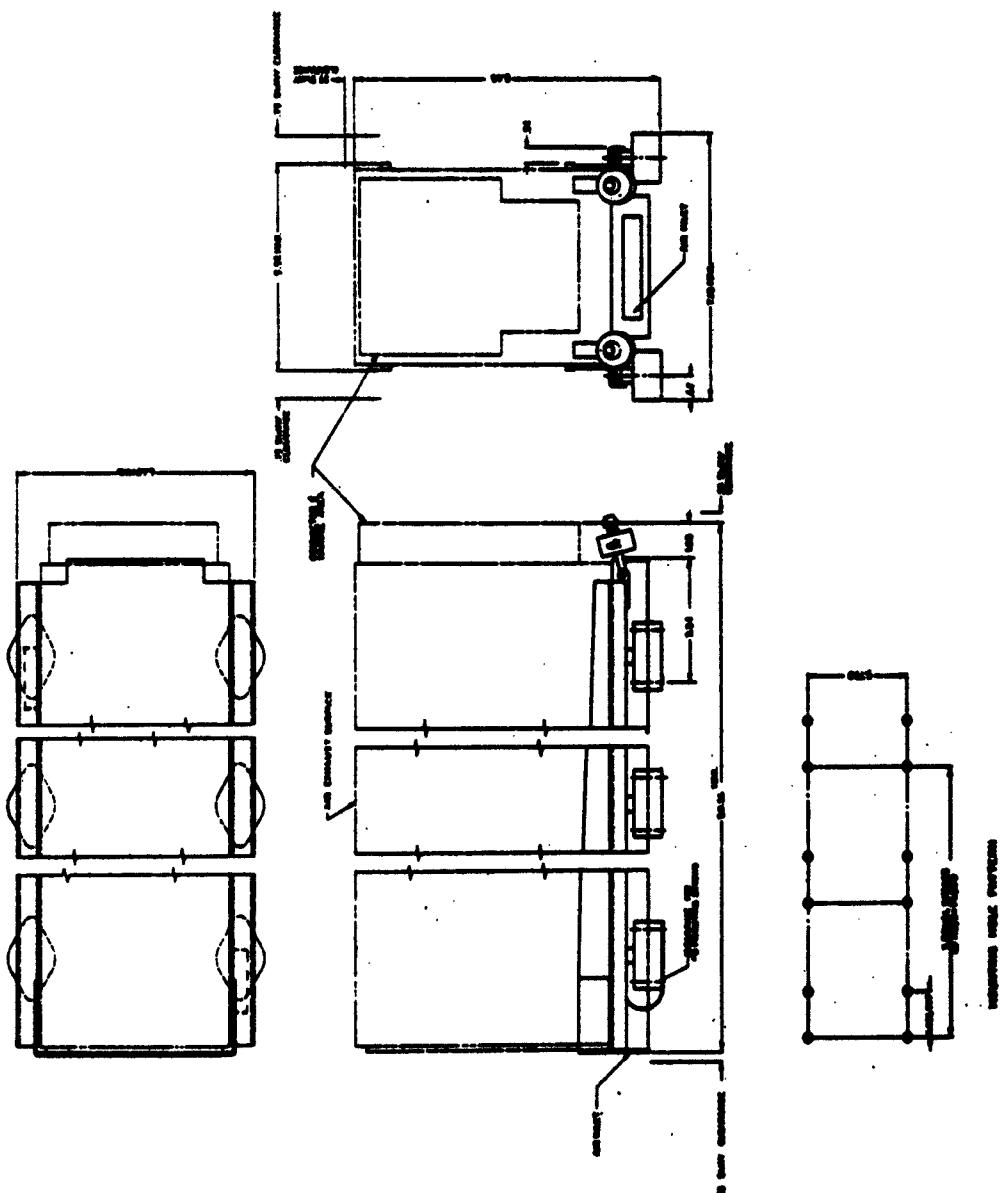


Figure II. Converter CV-1292 Mounting Base Layout Plan, 12-2064/ASU-2

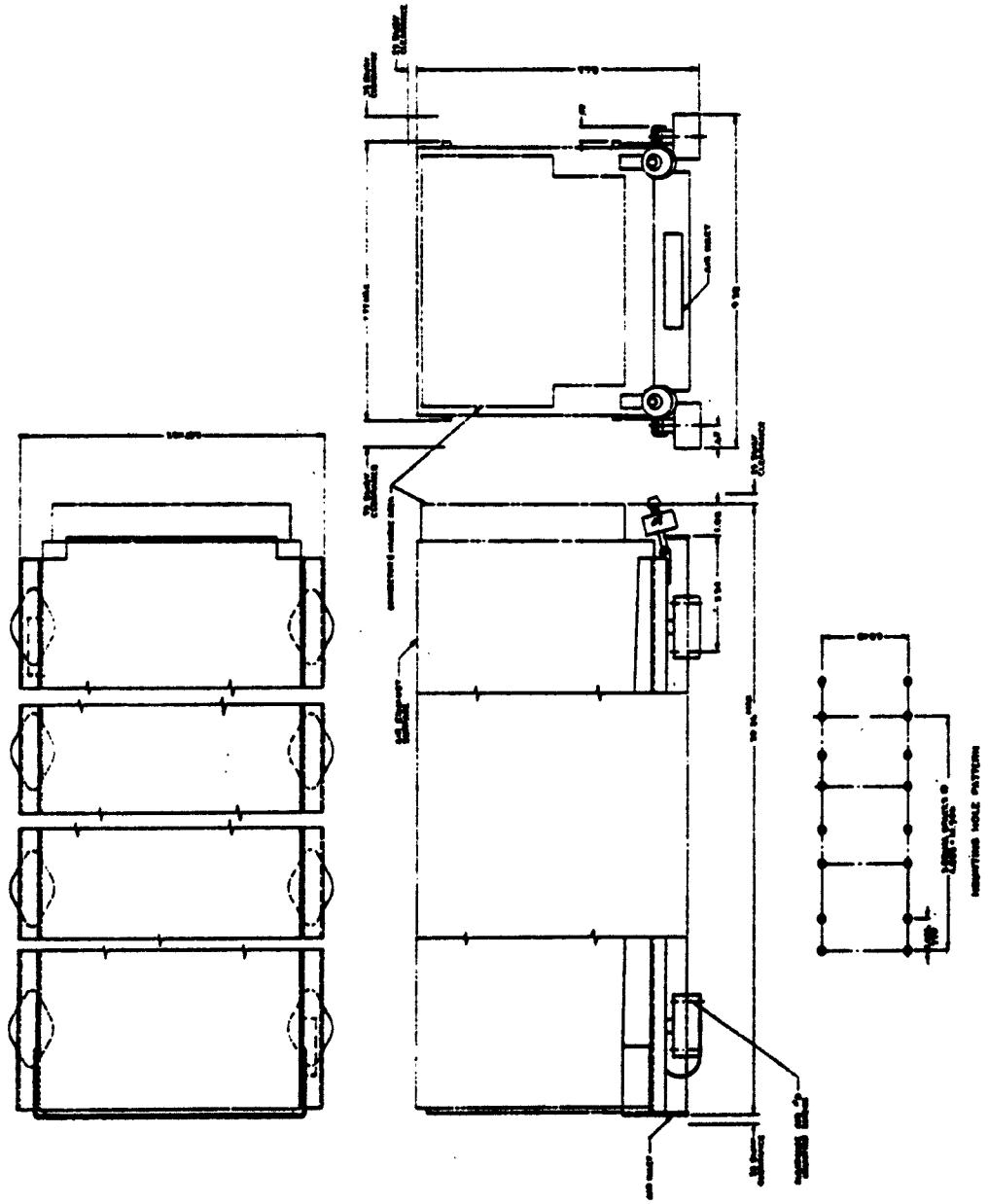
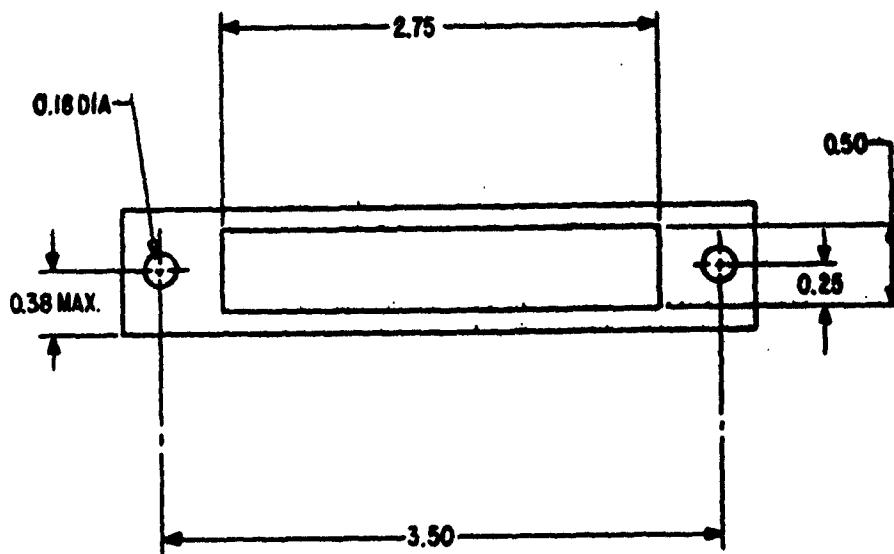


Figure I. Computer CP-671 Mounting Base Layout Plans, MT-2867/ASM-21



NOTE: ALL DIMENSIONS GIVEN IN INCHES

Figure XI. Input Duct Connector Mounting Dimensions

IV. Aerospace Ground Equipment

This section describes the Aerospace Ground Equipment developed by RCA to support the airborne communications systems described in this booklet.

The planned system test philosophy consists of: (1) flight line tests to detect and isolate faults to the lowest line replaceable unit, and (2) detailed shop tests and maintenance. This concept leads to the development of two types of test equipment referred to as the Flight Line Test Set (FLTS) and the Bench Test Harness (BTH). The FLTS is used to evaluate the readiness of a system prior to flight. It is capable of isolating a fault to the black box which can quickly be replaced by an operational unit in time to prevent an abort. The faulty unit is then repaired in the shop using the BTH to isolate the fault to the lowest replaceable part.

In some cases, such as the AN/ASW-21, the FLTS becomes the BTH when it is supplemented with an additional fault isolating equipment and the necessary interconnecting cables and fixtures.

A Data Link Flight Line Test Set, AN/ASM-98A

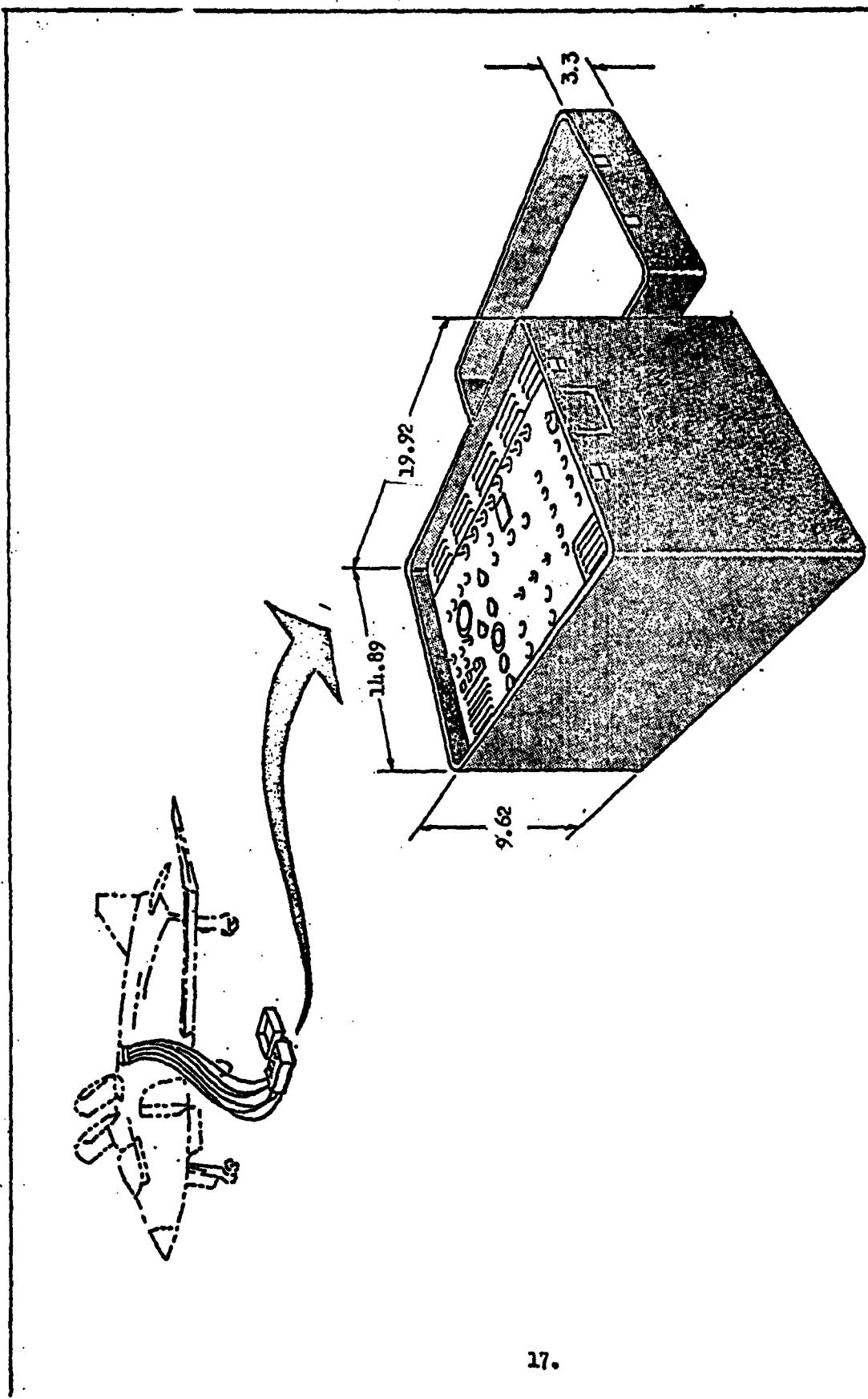
The AN/ASM-98A, developed under Navy Contract No. N0W-61-0918c, is a portable test set for performing flight line tests on Digital Data Communications Set AN/ASW-21. The tests will provide the operator with an evaluation of the system capability and, should a malfunction exist, identify the faulty unit (Converter CV-1292/ASW-21, Computer CP-671/ASW-21, or Control C-4085/ASW-21). The AN/ASM-98A also provides for coarse receiver sensitivity and transmitter power checks to isolate malfunctions to the associated radio set (AN/ARC-88 or AN/ARC-75).

The AN/ASM-98A is connected to aircraft test connectors by means of a set of test cables supplied with the test set as shown in Figures XII and XIII. The aircraft test connectors are incorporated in the aircraft as a portion of the overall data link system. A simplified block diagram of the AN/ASM-98A internal circuit functions and their relationships with the equipment being tested is illustrated in the block diagram, Figure XIV.

The assemblies contained within the AN/ASM-98A are: (a) the Message Generator and Digital Comparator, (b) the Analog Comparator, (c) the Radio Test Assembly, (d) the Power Supply, and (e) the Display Panel. The front panel contains all the controls, connectors, meters and indicators that are used in the performance of tests. All input power to the Test Set is supplied through circuit breakers located on the front panel.

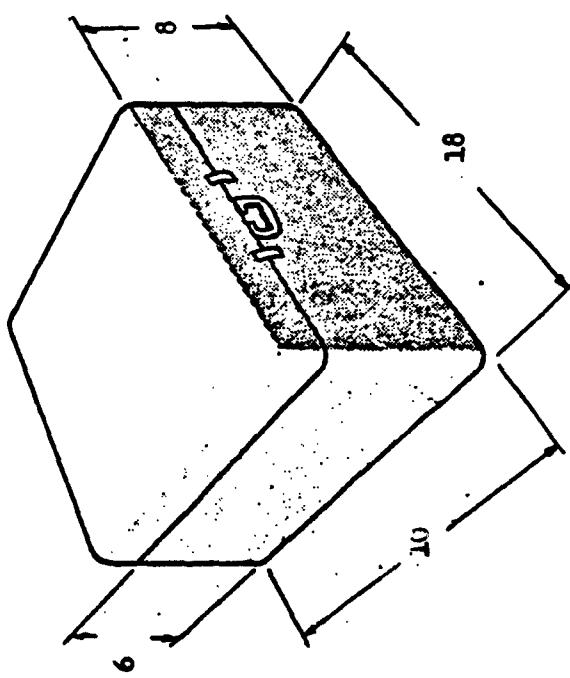
The major assemblies that comprise the AN/ASM-98A are located in easily accessible areas to facilitate troubleshooting. The power supply is located at the bottom of the main chassis and contains two blower motors that allow air to enter at the bottom-front of the case and exhaust at the top of the front panel. Two additional exhaust vents are provided at the rear and side of the case. A removable side panel is provided on the main chassis to permit removal of the message generator and digital comparator assemblies.

DATA LINK FLIGHT LINE TEST SET - AN/ASM-98A

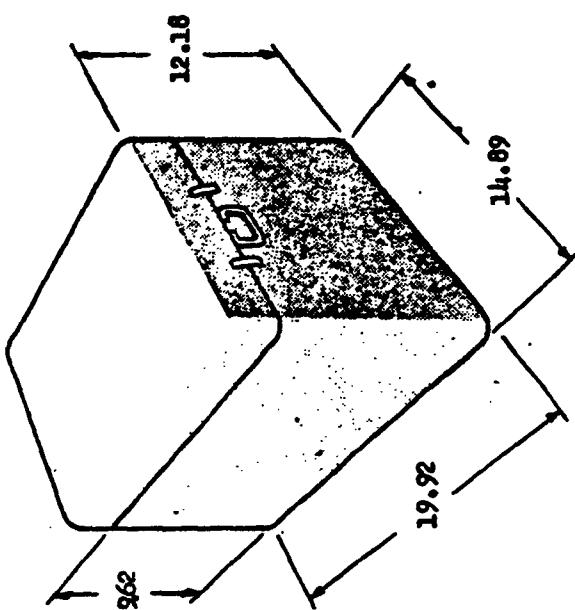


TEST SET

AN / ASM - 98A TEST SET & CABLE STORAGE CASE



WEIGHT OF CABLES = 10
WEIGHT OF CASE = 5
TOTAL WT. = 15



WEIGHT EXC. CASE = 39
WEIGHT OF CASE = 11
TOTAL WT. = 50

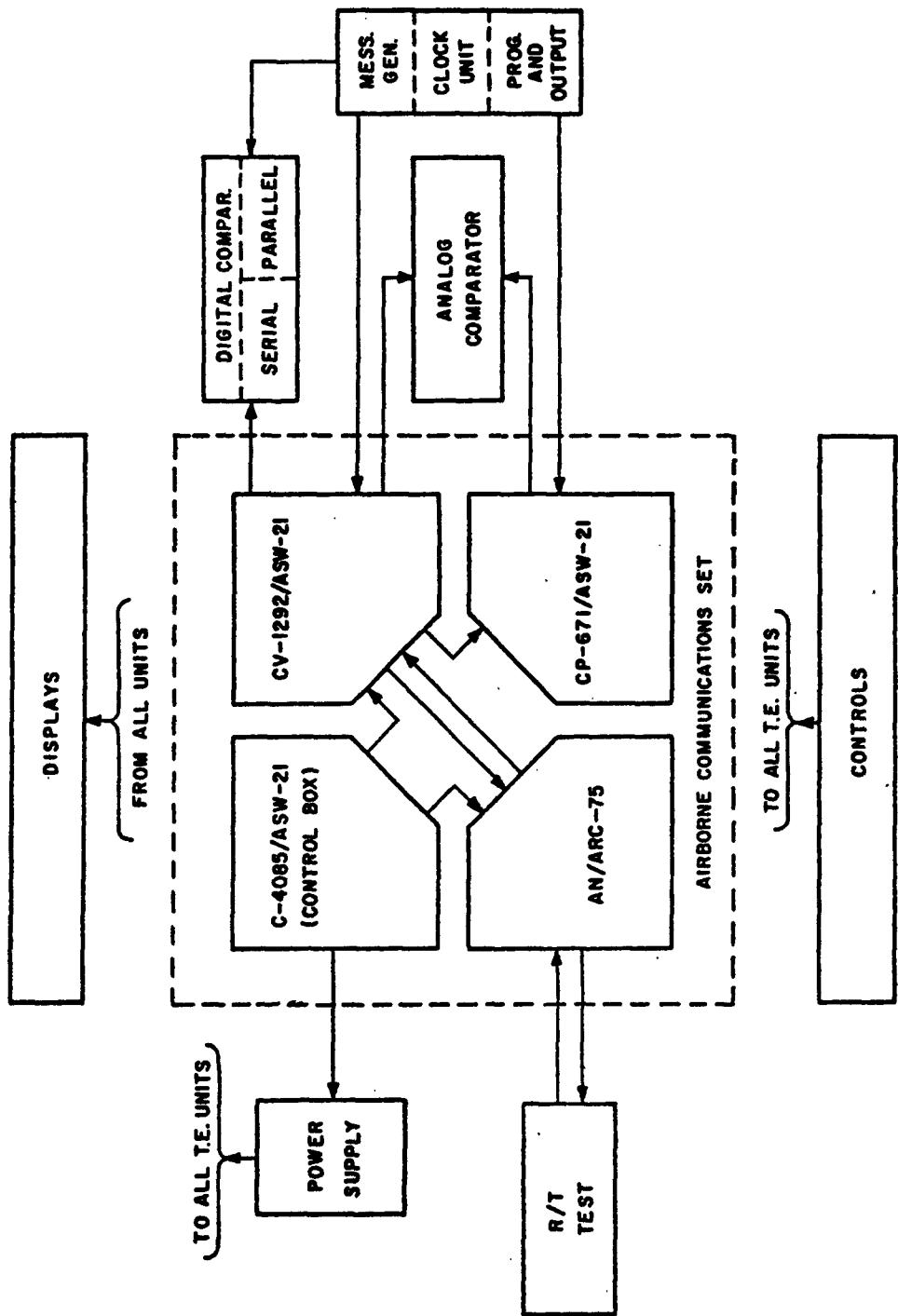


Figure XIV. Simplified Block Diagram, Test Set, AN/ASM-98A

The display panel is part of the front panel. The radio test set analog comparator assemblies are mounted on circuit boards near the rear of the main chassis.

Message Generator and Digital Comparator

Used to produce test messages consistent with the Joint Military Message Standards. Test messages are provided in the normal control message format and are initiated by a start signal from a front panel pushbutton switch. The reference reply output messages are initiated by the carrier-on signal from the airborne terminal during the reply function test of the CV-1292/ASW-21. The message generator also provides an antenna turn-a-round signal for further testing.

Also used to evaluate the digital responses (to the test stimuli) of the CV-1292/ASW-21 and provide the corresponding operational indications on the front panel. The comparator checks these digital responses and determines the operational capability of either the serial or parallel digital outputs of the CV-1292/ASW-21. Reply messages are verified utilizing a counter to verify the bit content.

Analog Comparator

Monitors and processes the analog outputs of the AN/ASW-21 and provides the applicable operational indications on the front panel. Also monitors and processes all of the analog responses to the test messages and provides the test results on the front panel.

Radio Test Assembly

Used to provide a coarse transmitter power evaluation, the radio test assembly sends an antenna turn-a-round signal and a 500-cycle square wave carrier-on signal to the Radio Set. Both signals are initiated and terminated by control switches on the front panel. The carrier-on signal is applied only for this test, to minimize the time full power output is

being produced by the transmitter. Also used in conjunction with a ground control terminal in evaluating the receiver sensitivity. While the AN/ASW-21 processes the Universal Test Messages radiated by the ground terminal, a coarse receiver sensitivity check is made by the radio test assembly.

Power Supply

Primary power for the power supply is obtained from the aircraft and is fed through the circuit breakers located on the front panel. All required operating voltages for the AN/ASM-98A are derived and distributed to the other assemblies.

B. Bench Test Harness, DigitalData, AN/ASM-128

The Bench Test Harness (BTH), also developed under Navy Contract No. N00w-61-0918c, is a shop test set for performing detail tests and maintenance of Digital Data Communications Set AN/ASW-21, and facilitates return of a malfunctioning equipment to a fully operable condition as rapidly as possible. Isolation of a malfunction to the lowest replaceable part is accomplished using semi-automatic troubleshooting techniques. The procedure includes first isolating a fault in the AN/ASW-21 to one of its major assemblies, i.e., Converter CV-1292/ASW-21, Computer CP-671/ASW-21, or Control C-4085/ASW-21. The faulty "frame" (a subassembly of circuit modules mounted on a pair of printed circuit boards housed in a metal frame) is then determined and removed from its assembly. A descriptive overlay is then laid over the module pins exposing only those pins applicable as per the test routine defined by that overlay. Using a test manual, an oscilloscope, voltmeter, etc., the malfunction is traced to the faulty module. This technique permits maintenance of a complex equipment of modular construction with a minimum of system downtime. The philosophy of design is considered an optimum compromise of test set complexity.

A simplified block diagram of the BTB is illustrated in Figure IV. The BTB consists of a Data Link Flight Line Test Set TS-1918/ASN-98A (described previously), an Analyzer, and associated cabling and storage, shown in Figure XVI.

Under the planned system test philosophy, AN/ASN-98A will isolate a malfunction in the AN/ASW-21 at the flight line to the Converter Computer, or the Control Box. The faulty assembly is then removed from the aircraft and replaced with an operational component. The assembly is then sent to the shop area and plugged into the appropriate adapter of the BTB where isolation of the fault is accomplished to the lowest possible level, the potted module. The faulty module is then replaced with a new module from spare parts utilizing the special tool provided. The assembly is then re-tested to verify the unit before returning it to operational status.

The system operation discussed below is described in terms of the tests to be performed on the particular assemblies of the AN/ASW-21 rather than in terms of the functions of the Flight Line Test Set and the Analyzer. This is done since the Analyzer is designed to supplement the Flight Line Test Set and a functional description of each would overlap.

Principles of Converter CV-1292/ASW-21 Tests

The TS-1918/ASN-98A provides timing and synchronization signals to the Analyzer and Data Link test messages to the converter. The Flight Line Test Set checks the serial readout of the command and reply messages; it also displays the analog outputs. A malfunction of any of these signals causes a deviation in the expected readout and corrective action may be taken.

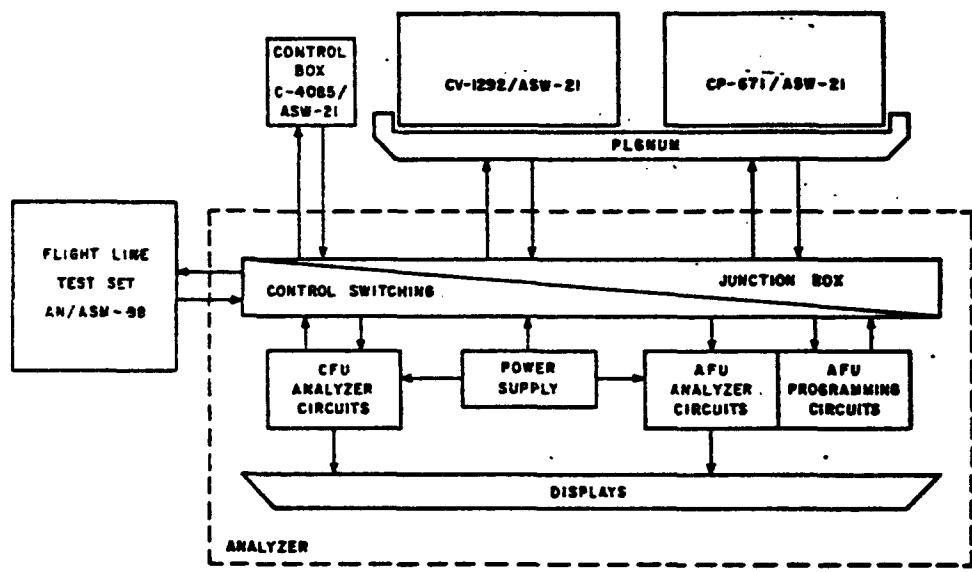


Figure XV. Simplified Block Diagram, Bench Test Harness

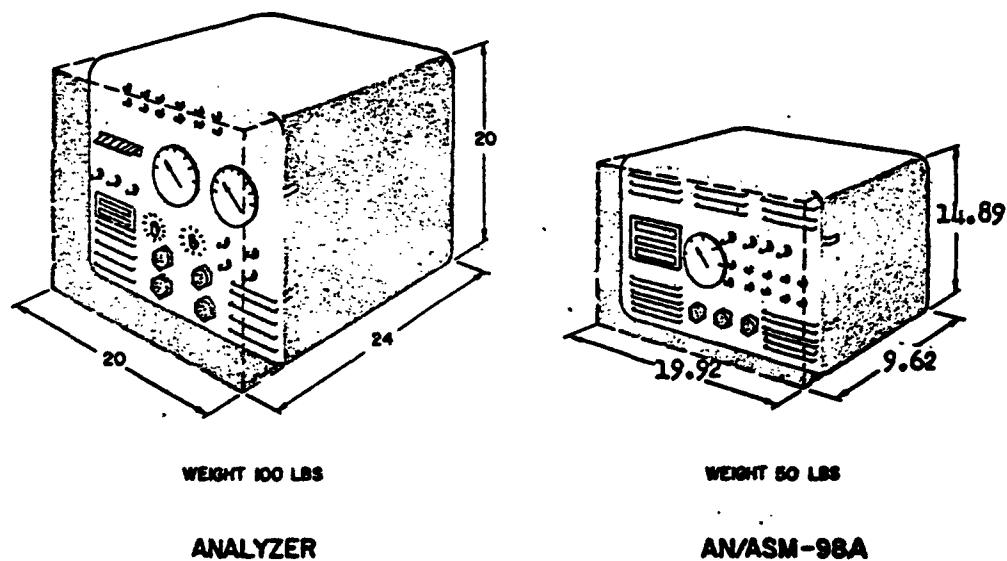


Figure XVI. Bench Test Harness Electronic Components Configuration

The Analyzer expedites the troubleshooting procedures by providing automatic lamp indications of malfunctions which are interpreted by the operator and thereby serve to direct him to a logical area on one of the printed boards. Each functional area provides test points that are routed to the Analyzer where a lamp indicator continuously monitors each point. An overlay is then used to isolate the faulty module.

The Converter processes the incoming Data Link test control message and generates output signals which are monitored and verified by the Analyzer.

The 42-stage shift register in the Converter that stores the control and reply messages is checked by a serial readout comparison in the TS-1918/ASM-98A. No further check of the control message is required by the Analyzer. The shift register is then cleared of the control message and the reply message circuits within the converter are activated.

Test points at the outputs of the functional areas of the reply message circuitry are used to monitor this section in the same manner as for the control message circuitry described above.

The analog output signals of the Converter are tested in the TS-1918/ASM-98A by means of an analog comparator and a meter readout on the front panel.

Principles of Computer CP-671/ASW-21 Tests

One of the three frames within the computer contains the "control unit" with the two printed circuit boards of the frame containing the program storage logic and the program decode logic. This frame must be verified first in the test of the computer since the logic contained herein dictates the nature of computer operations and the associated data routing.

The first test performed is a comparison of the 16 operations and 33 address outputs of the program decode logic. The test is made by generating similar signals within the analyzer and comparing these signals with those generated in the decode unit. The comparisons are made possible by bringing out the 49 parallel output lines as test points and routing them to the analyzer. Logic for program storage is also provided within the control unit with timing pulses generated by the analyzer.

A set of nine parallel lines connected to the nine stage program storage register and available to the analyzer as test points enables the operator to manually program the computer. These lines are energized by switches on the front panel of the analyzer. The combination of manual control of the program and of the program timing also enables the remaining functional areas that comprise the computer to be exercised as semi-independent subsystems.

If a malfunction is indicated as a result of the program comparison routine, analysis of the visual indicators on the analyzer serves to direct the operator to a logic area.

The operation of the seven storage registers are then checked. Two of the registers, the accumulator and the M₁ register, are contained on the same printed board as the arithmetic unit. The remaining five high-speed memory registers, including the "Z" register and the "Trig" register, are located on the second board of that frame along with the input logic circuitry. Procedures similar to those described above are employed here to verify these circuits.

The final functional area of the control unit to be checked is the arithmetic unit. The capability of being able to program manually is particularly valuable in the checkout procedure of this section of the

computer. In general, the procedure in requesting the arithmetic unit to perform its various calculations is similar regardless of the type of calculation to be made (addition, subtraction, multiplication, division). To minimize the number of test problems necessary to localize the faulty module within the arithmetic unit, a group of approximately 12 test points are brought out to the analyzer. These test points include the "B" input to the adder, the output of the sum/difference determiner, the control flip-flop, and a group of discrete lines.

After the checkout routine has been performed on the input logic and the accumulator and it is determined that they are functioning properly, the output section is verified. All of the output circuitry is contained in two printed boards, with the boards contained on the same frame. The checkout procedure of this functional area is routine and repetitive as there are 13 duplicate output circuits each consisting of a 7 to 10 stage shift register and a matching Digital-to-Analog Converter. Once a malfunction has been detected as being in the output circuitry, it is possible to minimize the number of modules to be checked with an overlay by applying a series of additional test routines.